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Effect of various foliar applied micronutrients (Zn+Fe+Cu+B) on growth and yield of wheat under Faisalabad condition

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The field trail was conducted at agronomy farm, University of Agriculture Faisalabad, Pakistan during winter 2020-21, to observe the response of micronutrients (Zn, Fe, Cu and B) on the wheat (*Triticum aestivum* L.) Micronutrients play an important role in the crop production of wheat. Micronutrients deficiency is a major issue which decrease the wheat yield and also deteriorate the quality of the grains. The experiment was comprised of foliar spray of M_0 (Control), M_1 (Zn), M_2 (Fe), M_3 (Cu), M_4 (B), M_5 (Zn + Fe), M_6 (Zn + Cu), M_7 (Zn + B), M_8 (Zn + Fe + Cu + B) treatments with three repetitions and the net plot size was be 3 m × 5 m. Randomized Complete Block Design (RCBD) was used. Sowing was done by broadcast sowing method, with a seed rate of 125 kg/ha. The fertilizer was applied @ 116:86:65 N:P:K kg/ha, respectively. In this study, an attempt was made to check foliar-applied micronutrients effect on growth stages, yield and yield-components of wheat. The results were evaluated statistically using Fisher's analysis of variance, and the treatment means were compared using Tukey's HSD test at a 5% probability level. The experiment results revealed that micronutrients application at booting stage significantly improved the performance of wheat crop and grain yield. Micronutrients application has a non-significant effect on plant height and number of productive tillers. Among different micronutrient combinations, the (Zn+Fe+Cu+B) treatment combination substantially improved the spike length (cm), No. of spikelets, number of grains, 1000-grain weight (g), grain yield (t ha^{-1}) and Harvest index (%). It can be concluded that (Zn+Fe+Cu+B) have significant effects on yield parameters as compared to other treatments.

Keywords: Wheat, micronutrients, exogenous application, booting, yield and yield components.

INTRODUCTION

Wheat is the highly valuable cereal of Pakistan and is also staple food in the country. In Pakistan, requirement of wheat is enhancing with the passage of time due to expansion of population and low yield per unit area. Based on researches, a statement indicates that Pakistan gains 2.5 times less yield as compared to the potential yield of advance countries (Khan *et al*., 2000). Wheat is the most nutritive cereal grain, with the highest nutritional value, and is regarded as a low-cost source of carbohydrates, nutrients, and vitamins (Kumar *et al*., 2011). It supplies about 20% of the food needs globally and is cultivated on 217 million hectares (FAO, 2012). In comparison to other cereals such as maize and rice, wheat is a necessary staple foodstuff for the majority of the world's population. Wheat is Pakistan's most common food grain. Wheat grains contain almost 12.1% fiber, 68% fat and 15.4% calcium (Anjum *et al*., 2005).

Wheat flour is made by grinding wheat grains, and it is mostly used to make unleavened bread. Its flour is also used to make "puri" and "paratha," which are fried chapati. Wheat is also used in many value addition products. In general, hard wheat flour is used to make bread, noodles, and biscuits. Low-grade flour is used as by-products of the flour-milling and distilling industries, mostly in the manufacture of bran, which is used as livestock feed and in the fermentation of alcohol. Among other uses in industry wheat is used to make starch, which is mostly used in laundry, paper lamination, corrugating glue,

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clothing cloth sizing, coffee substitutes, wall paper, billboard paste, and paper additives (Shingaki-Wells *et al.*, 2011). Major threat confronting the world, particularly developing countries, is deficiency of micronutrients (Mayer *et al.*, 2008). Micronutrients have a significant role in plant respiration and photosynthesis and their deficiency adversely affects physiological functions of plants, ultimately resulting in low yield (Farooq *et al.*, 2012). Main reason of low yield in wheat crop production is the farmer unawareness about the importance of micronutrients for crop production (Nazeer *et al.*, 2020). It is proved by research that micronutrients can help in the overall output enhancement (Rehm and Sims, 2006). Micronutrient deficiencies are a serious issue that has a global influence on food production. Almost all the soils in Punjab-Pakistan are of calcareous nature and have relatively large proportion of alkali, possess less organic matter and these become deficient in nutrients due to intensive cultivation on them and face nutrient mining owing to imbalanced fertilizer application (Rafique *et al.*, 2006). Zinc, Boron, Iron, Manganese, Copper and Molybdenum are necessary for optimum plant's growth and development (Zain *et al.*, 2015). Micronutrient deficits are becoming increasingly common but since introduction of high-yielding wheat varieties with a high grain/straw ratio. Roots are necessary to utilize micronutrients as soil concentrations are low. Because root biomass development lags behind increases in aboveground biomass. Plants absorb nutrients by root and leaf. But if soil situations are opposing and micronutrients are necessary, nutrients may be sprayed on plants through foliar application. Foliar application of nutrients is more operative to decrease loss of energy and to upsurge highest yield and nutrient use effectiveness (Mengel and Kirkby, 2001).

Foliar spray of nutrients control losses from the soil and is a much efficient method to improve economical yield and also improves the qualitative features of grains (Gul *et al.*, 2011). Micronutrients are critical for improving agricultural yields and crop sustainability, as well as human health and overcoming micronutrient deficiencies (Shiwakoti *et al.*, 2019). Therefore, the present study was planned to evaluate the effect of various micronutrients on various growth stages of wheat yield.

MATERIALS AND METHODS

A field trail was conducted to evaluate the impact of different micronutrients on yield of wheat during winter 2020-21. This field trial was carried out at Agronomic Research Farm, University of Agriculture, Faisalabad to assess the influence of exogenous application of micronutrients on yield and yield component of wheat. Before the commencement of the experiment, soil sampling was done in a zigzag pattern from a depth of 30 cm (1–15 cm and 15–30 cm). A composite sample was submitted for soil physio-chemical analysis and the report of soil analysis is represented in

Table 1. Soil Phsio-chemical properties

Physicochemical properties	Units	Analytical values
pH	-	8.10
O.M	%	0.99
N	%	0.05
P	ppm	7.79
K	ppm	161

The detail of all necessary weather indices is represented in Figures 1-6.

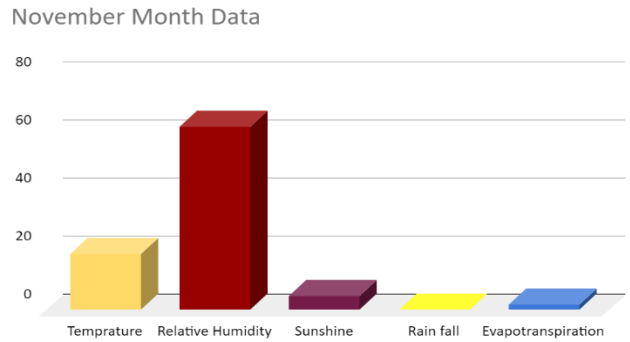

Figure 1. November Month Data 2020-21

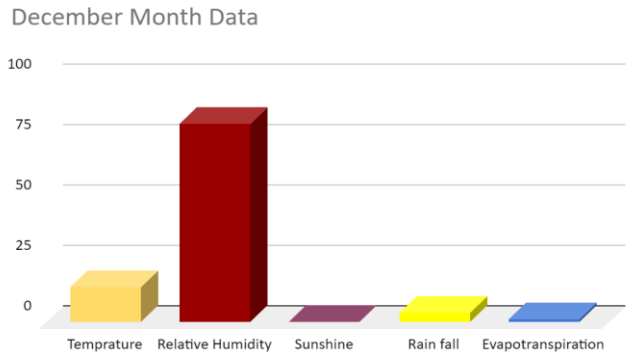

Figure 2. December Month Data 2020-21

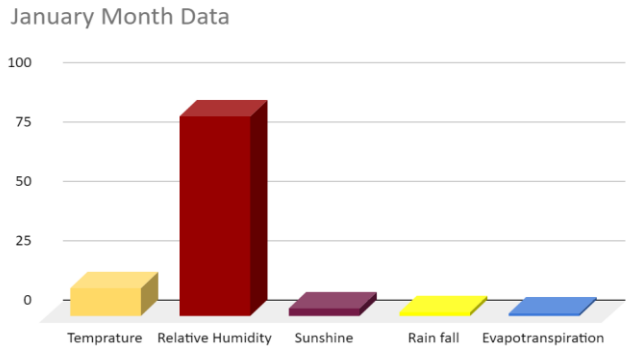

Figure 3. January Month Data 2020-21

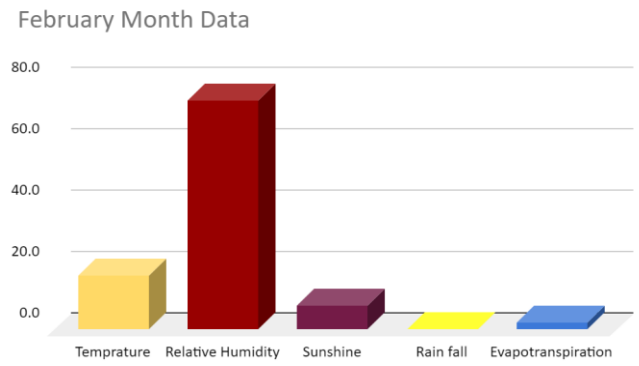

Figure 4. February Month Data 2020-21

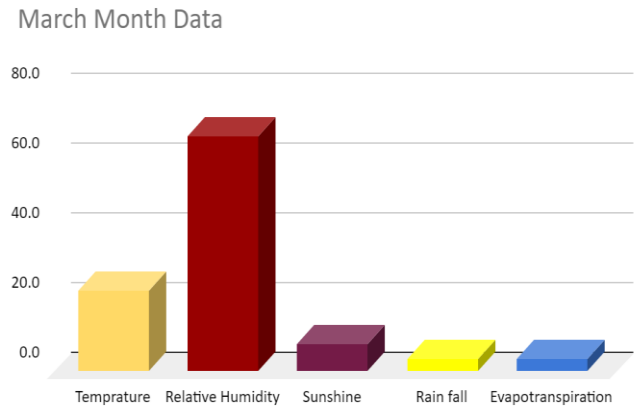

Figure 5. March Month Data 2020-21.

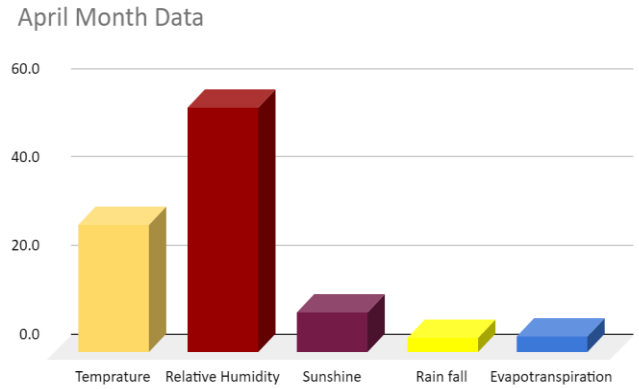

Figure 6. April Month Data 2020-21

Randomized complete block design (RCBD) was used to layout the experimental treatments with three replications. Combination of various micronutrients were applied at the booting stage by the foliar spray method. Recommended fertilizer dose of NPK @ 115:87:62 kg ha^{-1} the source of fertilizer was Urea, DAP and SOP, respectively. Full dose of DAP and SOP were used at seed bed preparation while nitrogen was applied in two splits. Total five irrigations were applied to crops at different growth stages. Weeds were controlled by chemical control for narrow leaf weeds pinoxaden and for broadleaf weeds bromoxynil was applied after 40 days of sowing. Sowing was done by broadcast method. Recommended seed was broadcasted @ 125 kg ha^{-1} of wheat variety Anaj-17 with the actual plot dimension was 3 m × 5 m and gross plot size was 3 m × 6 m. Data on following Agronomic parameters was recorded as per procedure given below.

RESULTS AND DISCUSSION

Plant height

Analysis of variance regarding height of plant inferred that the height was not significantly affected by foliar application of micronutrients (**Table 2**). Results indicated that there was no significant effect on plant height by foliar application of micronutrients at booting stage (**Table 2**).When plants start their booting stage after this there was no significant effect of foliar application of micronutrients on plant height of wheat (Nadim *et al*., 2011).

***Spike length (cm)*:** Spike length is a significant yield parameter since it is proportional to the number of grains per spike and hence plays a role in determining grain yield. Interactive impact of treatments was recorded as significant (**Table 2**). The maximum spike lengths (14.90 cm) were recorded in M_8 (Zn+Fe+Cu+B) treatment. While minimum spike length (12.53 cm) were recorded in M_2 where we apply copper (Cu) treatment. Similarly Comparative results exhibited that various micronutrients applications were significantly different with respect to spike length of wheat. Micronutrients application on the booting stage of wheat significantly increases in spike length. Better micronutrients availability helped in proper nutrition which resulted in increased ear length and thus more number of grains per ear. Foliar supply of micronutrients aims to supply nutrients according to the requirements of a specific field or growing environment. Right amount of micronutrients have resulted in higher spike length. This could be due to consistent supply and availability of recommended doses of nutrients to spike during the reproductive phase (Sharma *et al*., 2004).

***Number of grains per spike*:** Interactive impacts of treatments were recorded as significant at 5% probability level (**Table 2**). Statistically maximum (66.00) grains per spike were recorded in M_8 (Zn+Fe+Cu+B) treatment. While minimum (49.00) grain per spike was recorded in M_0 (Control) treatment. Similarly, the comparative results exhibited that various micronutrient application was significantly different with respect number of grain per spike. The current outcomes are in lined with the research of Arif *et al*., (2006) revealed that the application of micronutrients significantly effect on grains $spike^{-1}$. Number of grains/spikes was more by three sprays of micronutrient as compared to single spray.

***Number of spikelets*:** As much the number of spikelets per spike means the more grain-yield. Application time have

Table 2. Effects of exogenous application of different micronutrients on yield and yield

Treatments	Plant height (cm)	Spike length (cm)	No of spikelets	No of grains	1000-Grain Weight (g)	G.Y (t ha^{-1})	B.Y (t ha^{-1})	H.I%
M_0 (Control)	83.69	13.08CD	16.00C	49.00C	35.00B	4.47G	11.70BC	37.88I
M_1 (Zn)	85.37	13.15CD	19.00ABC	54.00BC	37.00AB	4.68E	11.64C	40.20F
M_2 (Fe)	85.26	12.53D	17.00BC	52.00BC	35.00B	4.56F	11.49CD	39.68G
M_3 (Cu)	82.68	13.15CD	17.00BC	52.00BC	34.33B	4.58F	11.78BC	38.87H
M_4 (B)	85.32	13.72C	21.00AB	62.00AB	38.66AB	4.91D	11.80B	41.61D
M_5 (Zn + Fe)	86.31	13.26C	19.00ABC	58.00ABC	37.00AB	5.03C	11.88AB	42.34B
M_6 (Zn + Cu)	82.73	13.72C	19.00ABC	56.00ABC	37.00AB	5.04C	12.33A	40.87E
M_7 (Zn + Br)	84.67	14.29B	21.00AB	63.00AB	40.66A	5.09B	12.13A	41.96C
M_8 (Zn+Fe+Cu+Br)	83.67	14.90A	22.00A	66.00A	41.66A	5.12A	11.80B	43.38A

significant effect on number of spikelets per spike. Interactive effect of treatments was found to be significant at 5% probability level as shown in (**Table 2**). Statistically maximum (22.00) number of spikelets were recorded in M_8 (Zn+Fe+Cu+B) treatment. While minimum (16.00) number of spikelets was recorded in M_0 (Control) treatment. Similarly comparative results exhibited that various micronutrient applications were significantly different with respect to the number of spikelets of wheat. The findings are similar to those of the previous study who discovered that the larger number of fertile tillers per plant caused the increase in the number of spikes and spikelets per unit area. A plentiful supply of micronutrients may have increased the availability and uptake of other critical nutrients, causing an upsurge in the number of spikelets per spike (Rahimi *et al*., 2012).

***1000- grain weight (g)*:** 1000- grain weight depicts the boldness or size of the grain. Interactive effects of treatments were found to be significant as given in (**Table 2**). Statistically maximum (41.66 g) 1000 grain weights were recorded in M_8 (Zn+Fe+Cu+B) treatment. While minimum (34.33 g) 1000 grain weight was recorded in M_3 (Cu) treatment. Similarly, comparative results exhibited that application of various micronutrients significantly differed with respect to 1000 grain weight of wheat. The outcomes are similar with Guenis *et al*. (2003) results who described that foliar spray of micronutrients has a crucial role in grain filling and grain test weight. Plentiful supply of micronutrients with foliar spray significantly improves thousand grain weight. Especially when micronutrients were applied through foliar spray and at the booting stage of wheat it improves 1000 grains weight of wheat. Current findings are compared with the previous research which show that Malakouti (2008), stated that applying different micronutrients to plants with different methods (foliar application, soil application and side dressing etc) have beneficial impacts on wheat.

***Grain yield (t ha^{-1})*:** Grain yield refers to quantify crop yield per unit area of land and seed production itself. Interactive effects of treatments were found to be significant given in (**Table 2**). Statistically maximum grain yield (5.12 t/ha) was recorded in M_8 (Zn+Fe+Cu+B) treatment. While minimum (4.47 t/ha) grain yield was recorded in M_0 (Control) treatment. Similarly, the comparative results showed that foliar application of micronutrients was significantly different with respect to grain yield of wheat. The results of previous studies supported that the micronutrients application at late growth stages of wheat produced greater yield as compared to early vegetative growth stages. Foliar application of micronutrients at the reproductive growth stage considerably increased grain and straw output in wheat. This result was supported with research Microelements effectively improved photosynthesis and assimilate translocation to the seed by increasing enzymatic activity (Khan *et al*., 2006). Current findings are compared with the previous research which show that Kumar *et al*. (2009), documented 69% yield upsurge over control with the spray of Cu. Mn not only resist the plants against various soil borne diseases nevertheless too fungal leaf ailments like black leaf mold in tomato, powdery mildew in grape and 10 spots in wheat and augmented crop yield (Heine *et al*., 2011).

***Biological yield (t ha^{-1})*:** In a plant system biological yield refers to the total dry matter accumulation. Interactive effects of treatments were found to be significant as shown in (**Table 2**). Maximum (12.33 t ha^{-1}) biological yields were recorded in M_6 (Zn+Cu) treatment. While minimum (11.49 t ha^{-1}) biological yields were recorded in M_2 (Fe) treatment. Similarly, the comparative results exhibited that application of various micronutrients significantly differed with respect to biological yield. Similarly, Kaya *et al*. (2000), and Cakmak, (2008), have also advocated that micronutrients beneficial in producing higher biomass in plants. The significance of foliar spray of micronutrients (Zn) in producing superior yields may be due to their vibrant contribution in crop development, comprising of respiration, photosynthetic mechanism and other biological and physiological events. The scientists found earlier that foliar spray of micronutrients improves biological yield, crop index, straw and kernel yield in various phases of wheat growth (Pandey *et al*., 2020). This rise in biological yield might be due to Zn application as it plays significant role in plant growth and involved in photosynthesis, many physiochemical

processes and respiration is significant in attaining higher returns (Zeidan *et al.*, 2010). Similarly, Kaya and Higgs (2000), and Cakmak, (2008), have also advocated that Zinc beneficial in producing higher biomass in plants.

***Harvest index (%)*:** The harvest index was determined by dividing the grain yield on biological yield. Interactive effects of treatments were found to be significant as shown in (**Table 2**). Maximum (43.38 t ha^{-1}) harvest index % were documented in M_8 (Zn+Fe+Cu+B) treatment. While minimum (37.88 t ha^{-1}) harvest index % were documented in M_0 (Control) having mean value. Similarly, the comparative results exhibited that application of various micronutrients significantly differed with respect to the harvest index of wheat. The results of previous research indicated that harvest index increases with increase in fertilizer doses. It is also reported that higher above ground biomass is noted in foliar application of micronutrients (Gupta *et al.*, 2011).

***Conclusion*:** The current experimental work showed that the micronutrients have a great importance in the productivity of wheat. Deficiency of micronutrients hampered the growth, yield and productivity of wheat drastically. But foliar application of micronutrients has substantial effect on growth and yield of wheat plant. Foliar spray of micronutrients significantly improved the agronomic and yield contributing parameters such as spikes length, grain per spike, grain yield, harvest index and 1000 grain weight of wheat. The treatment M_8 (Zn+Fe+Cu+B) among other micronutrient combinations significantly improved yield-related attributes of wheat.

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***Conflict of interest*:** No conflict of interest is declared by authors

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